SPECIFICATION

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Method of Applying Waste Rubber Materials for Construction of Golf Courses and Athletic Fields

Cross Reference to Related Applications

none

Federal Research Statement

The inventors did not receive any funding from federal or state agencies for this invention.

Background of Invention

[0001] Many industrialized nations battle with an increasing number of stockpiled tires, a problem that introduces serious environmental, aesthetic, and health risks such as providing a breeding site for mosquitoes. The environmental impact is extremely evident when stockpiled tires catch fire, a situation that is difficult to extinguish and releases harmful gases into the atmosphere.

[0002] The Environmental Protection Agency reported 31% of discarded tires were landfilled, stockpiled, or illegally dumped in the United States in 1995 totaling nearly 78.5 million tires (EPA, 1996). Only three years later, the numbers increased to 34% discarded in the same manner accounting for 92.5 million tires (National Rubber Association, 1998). To further amplify the problem, by 1998, 48 states had scrap tire regulations, 33 states had banned whole tires from landfills, and 12 states had prohibited all scrap tires from landfills. In the same year, approximately 500 million tires were in stockpiles.

[0003] In recent years, crumb rubber has become a popular material for civil engineering

applications such as road construction, and the turfgrass industry has found it useful as topdressing for increased traffic tolerance and compaction resistance in turfgrass (Jaitire Inc., 2000). In two field studies, one by the Minnesota Pollution Control Agency (1990) and the other by Humphrey and Katz (1995), tire chips placed underground were found to have no significant effect on groundwater quality despite the fact that some chemicals potentially leach from shredded tires. Their results have been supported by similar research (Scheels and Park, 1995) concluding that these applications are environmentally safe and beneficial for reducing tire stockpiles. Scrap tires have been used in asphalt pavement for the following reasons: longevity of pavement, reduced noise, reduced freeze-thaw damage, etc. Tire chips can significantly reduce the potential for freeze-thaw damage. Scheels and Park (1995) demonstrated that even at -50 ° F, a crumb rubber-amended soil bed did not freeze and the hydrogen sulfide reduction remained unaffected.

[0004] Through research conducted at the University of Wisconsin-Madison since 1991, crumb rubber has been found to restrict the breakthrough time of organics dissolved in water by adsorption (Park et al., 1996). Golf course greens and other turf generally require chemical applications to maintain turf quality. The current USGA design (USGA, 1993) allows rapid movement of water through the soil profile, which indicates the potential for water-soluble chemicals to leach through the system (Cisar and Snyder, 1996; Johnston, 1998) and contaminate ground water. Therefore, the implementation of crumb rubber into a sub-layer of golf course greens could adsorb chemicals dissolved in water, thus protecting water quality. Furthermore, the physical properties of crumb rubber may be beneficial for golf course greens when the winter temperature drops below freezing for a long period of time.

[0005] Two roadbeds constructed with shredded tires self-heated and caught fire in 1996. These sites contained thick sections of tire chips of 7.9 and 15 m thick. Humphrey et al. (1998) decreased the thickness of the tire layer and found that temperatures were decreasing after a slight increase. It was recommended that the thickness of a tire shred layer be limited to three meters and that relatively large shreds with a minimum of rubber fines be used along with limiting the flow of air and water into the interior of tire-shred fills (ASTM D6270-98).

[0006] USGA golf course greens are currently constructed based on stringent standards that identify the distinct layer depths and particle size distribution of construction materials (USGA, 1993). The construction standards outlined by the USGA consist of the top 30 cm layer (root zone mix) of sand amended with peat and the underlying 10 cm pea gravel layer. Golf course green construction standards established by the USGA are designed mainly to improve the playability of golf, not environmental impact. Since many greens are built near groundwater levels or wetlands, it is vital to consider the mitigation of environmental contamination caused by pesticides and fertilizers used in golf courses. Furthermore, the public in general demands better environmental protection during golf course construction and operation.

[0007] Sand based root zones, typically 80% or more sand by volume, have become the typical method of construction for putting greens and are increasingly being used for athletic fields and other high traffic turf areas. Sand based root zones are designed for rapid drainage of water to prevent surface puddling and compaction. Specific construction instructions have been published (USGA, 1993; Puhalla et al., 1999). The root zone is usually amended with peat or other organic materials to promote water and nutrient retention; however, these materials are only partially effective and decompose fairly rapidly. In most cases, a layer of gravel (10 cm depth), is used to "perch", or slow the drainage, as water will not readily drain from a finer textured soil into a coarser textured soil until sufficient water (field capacity) has accumulated to allow gravity to overcome the cohesive-adhesive forces of water. The water then drains through the gravel layer and into the subsoil. The low adsorption capacity of sand allows leaching of nutrients and chemicals into the ground (Cisar and Snyder, 1996; Johnston, 1998), which may contaminate groundwater and harm the environment.

[0008] Several patents have been issued related to the use of discarded rubber tires and soil or turf uses. Pluenneke (U.S. Pat. No. 4,166,340) describes a method of using the fibers (cotton, nylon and rayon) from pulverized tires as a lining material in plant pots to prevent soil loss. Tomarin et al. (U.S. Pat. No. 4,396,653) describes the application of crumb rubber topdressing into synthetic fiber playing surfaces, designed to keep the fibers upright in order to simulate a natural grass surface, and to provide resiliency to the field surface. Malmgren et al. (U.S. Pat. No. 5,014,462) described a

process of amending native soil root zones with shredded rubber prior to turf establishment to increase soil porosity and minimize compaction. The rubber was not added in a uniform layer, but rather mixed between 10-30% by volume into the top 7.6 to 15.2 cm of soil in order to simulate the drainage and compaction properties of sand based root zones by increasing the amount of macropores. The invention also described use of the rubber-soil mixture as a base for sod production. The invention claimed improved water and fertilizer use efficiency because turf roots could grow better in the more porous root zone. Rogers et al. (U.S. Pat. No. 5,622,002) described a method of applying a thin layer (0.25 to 1.9 cm) of crumb rubber topdressing to the surface of natural grass. The method was designed to improve the color and growth of the turfgrass by a) protecting the turfgrass crowns (meristems; buds) and b) increasing the temperature of the turf surface.

[0009] Herd et al. (U.S. Pat. No. 5,823,711) described a method of constructing a "water drainage and collection system"on golf course fairways to channel water into a holding area. The channel was to be placed below the surface of the turf, lined with an impervious barrier then filled with scrap tires. The tires would ideally be whole tires tied into a bale to allow rapid water drainage by forming a pseudo-pipeline. The claim was made that fertilizer and pesticide runoff could be prevented because water would be effectively channeled into a reservoir. The collected water could then be pumped from the reservoir and recycled for golf course irrigation.

[0010] Our claims are unique because our aim is not to channel water, but to adsorb and passively remove fertilizer and pesticide molecules from water as it percolates through the soil. The increased rubber surface area and uniform layer of crumb rubber in our invention provides a critical mass and surface exchange sites to adsorb nutrients and chemicals from drainage water before it reaches groundwater. No impervious barriers are used in our system to block the downward (gravitational) flow of water. This is important as water, when drawn from an aquifer or surface water, needs to be returned to the site so as to "recharge" the system. Ideally, the returned water is not contaminated with environmentally harmful pollutants. The uniform layer of crumb rubber, 10 cm depth, may perch the water table as per USGA specifications for putting green construction. The layer may also generate sufficient subsurface heat to promote turf foliar and root growth longer into the autumn/winter than would

otherwise occur and promote earlier growth in the spring. Extending the growing season by aiding turf growth further into the autumn and promoting it earlier in the spring are desirable to increase turf cover and aid recovery from traffic resulting from late or early season play.

[0011] It is an object of this invention to disclose methods of using waste rubber materials such as scrap vehicle tires as a construction material for turf areas such as golf courses and athletic fields. This method is also extended to removing contaminants from water as it percolates through soils or before entering into detention ponds or water bodies.

[0012] It is a further object of this invention to use waste rubber materials as a lightweight backfill material for construction of turf areas such as golf courses and athletic fields in wetlands and soft grounds.

[0013] An additional object of this invention is to lengthen the growing season by adding heat in the fall and early spring and retaining heat during the winter due to the insulating effect of the underground layer of waste rubber materials.

[0014] The last but not only object of this invention is to use waste rubber materials as a supporting layer for athletic fields to provide shock absorption and uniform rebounding characteristics.

Summary of Invention

[0015] The method of this invention pertains to the use of waste rubber materials for construction of turf areas such as golf courses and athletic fields to use the following properties of waste rubber materials: capability of adsorbing contaminants, insulation, a lightweight construction backfill material, and shock absorption. Waste rubber materials are used in lieu of or in addition to a pea gravel drainage layer underneath the root zone of turf areas such as golf course greens and athletic fields. This method will allow for the capture of pesticides and fertilizers applied to turf, thereby reducing potential groundwater contamination; the early thawing in spring due to insulation effect by waste rubber materials and thus potential early spring growth of turf; and the construction of turf areas in wetlands or soft grounds. This method also includes the construction of drainage systems in fairways, tee boxes, putting greens, and other

turf areas. Stormwater runoff from turf and other vegetated areas can be filtered with a layer of waste rubber materials to remove contaminants and particulates before entering into detention ponds or discharging into sewers due to the adsorption and filtration of contaminants by waste rubber materials.

[0016] The first application of this invention is the replacement of or addition to the pea gravel layer specified in the USGA green construction standards or other turf areas with waste rubber materials. This will result in mitigation of potential groundwater contamination by pesticides and fertilizers and longer growth period of turf.

[0017] The second application of this invention is the use of waste rubber materials as a backfill material for drainage systems constructed for turf areas such as golf courses and athletic fields.

[0018] The third application of this invention is the use of waste rubber materials as a lightweight backfill material for constructing turf areas such as golf courses or athletic fields in wetlands and soft grounds.

[0019] The fourth application of this invention is the use of waste rubber materials as a filter medium for removing contaminants in runoffs from turf or vegetated areas before entering into detention ponds or waterbodies.

[0020] The last application of this invention is the use of waste rubber materials as a supporting layer for athletic fields to provide shock absorbing potential and uniform rebounding characteristics.

[0021] The use of waste rubber materials for the construction of golf courses and athletic fields has the following advantages:

[0022] (1) Adsorption of contaminants

[0023] (2) Insulation

[0024] (3) Lightweight

[0025] (4) Shock absorbing property

[0026] (5) Potentially lower cost

[0027] (6) Environmentally sustainable technology.

Brief Description of Drawings

[0028] The configurations of the present invention are revealed in the following drawings.

[0029] FIG 1a, b, c, and d are 3-dimensional views of a golf course green or athletic field utilizing waste rubber for the material properties of adsorption of contaminants, lightweight, and insulation.

[0030] FIG 2 is a 3-dimensional view of a filtering apparatus that will contain waste rubber as a filter medium.

[0031] FIG 3 is a 3-dimensional view of an athletic field utilizing waste rubber for the material properties of shock absorption and resiliency.

Detailed Description

[0032] It is disclosed that when waste rubber materials are used as a drainage layer in turf areas such as golf courses and athletic fields, the quality of turf grass is improved due to the insulation property of waste rubber materials, and the potential for groundwater contamination is significantly reduced due to the adsorption of contaminants such as nutrients and pesticides by waste rubber materials. When the invention is applied, it is possible to construct environmentally friendly and sustainable man-made recreational areas even in environmentally sensitive areas.

[0033] The first example application of this invention is the replacement of or addition to the pea gravel layer specified in the USGA green construction standards or other turf areas with waste rubber materials. This will result in the mitigation of potential groundwater contamination by pesticides and fertilizers and a longer growth period of turf. FIG 1a, b, c, and d show 3-dimensional views of a turf area that requires a drainage layer and utilizes waste rubber such as a golf course green or athletic field of the present invention. The system is typically comprised of a root zone layer 1, optional intermediate layer 2, drainage layer 3, drainage trench 4, perforated drain tile 5, and a suitable subsoil foundation 6. The root zone 1 consists of sand amended with peat. The optional intermediate layer 2 is coarser sand (a) or waste rubber (c, d) that is recommended mainly to increase the bridging factor between the root zone layer 1

and drainage layer 3. The drainage layer 3 and drainage trench 4 are pea gravel (a, c) or waste rubber (b, d). All material size specifications as well as the determination of the need for an intermediate layer are based on the particle size and gradation specifications provided by the USGA for golf course green construction (USGA, 1993).

[0034] The second application of this invention is the use of waste rubber materials as a backfill material for drainage systems constructed for turf areas such as golf courses and athletic fields.

[0035] The third application of this invention is the use of waste rubber materials as a lightweight backfill material for constructing turf areas such as golf courses or athletic fields in wetlands and soft grounds.

[0036] The fourth application of this invention is the use of waste rubber materials as a filter medium for removing contaminants in runoffs from turf or vegetated areas before entering into detention ponds, wetlands, or water bodies. The filtration system should be designed to have a contact time from 30 seconds to 30 minutes depending on type and concentration of contaminants to be removed. The filtration system shall be operated in an upflow or downflow mode with or without a layer of sand below the waste rubber material layer. FIG 2 shows a 3-dimensional view of a mechanism for containing waste rubber materials while runoff is passed through the system of the present invention. The containment device is typically made of a wire mesh material *1* , top access lid for waste rubber installation *2* , and an internal wire mesh wall *3* for additional structural stability. The mesh hole, waste rubber, and overall system sizing are dependent on the expected influent flow rate and desired effluent flow rate.

[0037] The last application of this invention is the use of waste rubber materials as a supporting layer for athletic fields to provide shock absorbing potential and uniform rebounding characteristics. FIG 3 shows a 3-dimensional view of an athletic field that utilizes waste rubber as a supporting layer. The system is comprised of a 2.5 to 15 cm layer of waste rubber *2* located within the top 6 inches from the turf surface *1* . The waste rubber layer is partitioned *3* to increase stability within the waste rubber zone. Layers *1* and *2* can be constructed on a variety of acceptable foundations *4* such as soil or concrete. The partitions *3* can be constructed out of a variety of materials with selection based on factors such as material cost, availability, installation, and

resistance to environmental stresses.

[0038] The size of waste rubber materials claimed in this invention for the replacement of or addition to the pea gravel drainage layer ranges from 1 to 12 mm. The size of waste rubber materials for other claims is not an important factor; thus, the size should be determined based on availability, workability, constructability, and performance factors. It is also possible to use tire chips without further refinement with the size range of 0.25 to 10 cm in the case where there is no need for finer size materials for construction.

[0039] The waste rubber materials claimed in this invention includes scrap vehicle tires, industrial and automobile belts, rubber wastes generated from manufacturing of shoes, baby bottle nipples, gaskets, and other products, all of which are free from external contaminants.

[0040] Turf is natural grass, artificial playing surfaces, or various combinations of the two.

[0041] Ground rubber is a refined waste rubber material where steel wires, textile cords, and/or other materials except rubber are removed. Chipped waste rubber does not go through any separation besides size reduction and thus contains steel wires, textile cords, and other materials.